Main Street Bridge
Intersection of Main Street
(New Hampshire Route 2 and 3) and Israels River
Lancaster
Coos County
New Hampshire

HAER No. NH-17

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
MID-ATLANTIC REGION, NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR
PHILADELPHIA, PENNSYLVANIA 19106

HAER NH 4-LANC, 1-

HISTORIC AMERICAN ENGINEERING RECORD

MAIN STREET BRIDGE HAER No. NH-17

Location: Intersection of Main Street (New Hampshire Route 2 and 3) and Israels River in the Town of Lancaster, Coos County, New Hampshire, 1.65 miles east of the Vermont/New Hampshire state line and 3.95 miles south of Lancaster/North Umberland town line.

USGS Whitefield Quadrangle, New Hampshire-Vermont 1935

UTM: 19.295700.4929000

Date of Construction: 1929

Engineer: Daniel B. Luten, The Luten Engineering Company, Indianapolis, Indiana

Present Owner: New Hampshire Department of Transportation Concord, New Hampshire

Present Use: Vehicular bridge

Significance: The Main Street bridge is one of approximately forty concrete arch bridges extant in New Hampshire. It is one of eleven extant bridges built by Daniel B. Luten in the state of New Hampshire between 1927 and 1931. Constructed in 1929, the Main Street Bridge is the only example in the state of a two-span, reinforced concrete closed spandrel, multi-rib arch bridge built by Luten. The Main Street bridge is the eighth structure to span the Israels River at this location. The Main Street bridge was determined eligible for the National Register of Historic Places in 1986 as part of the Downtown Commercial Historic District. The Main Street Bridge serves to unite two sections of the downtown commercial district which are separated by the Israels River.

Project Information: This documentation was undertaken in September-October 1989 in accordance with Memorandum of Agreement by the New Hampshire Department of Transportation as a mitigative measure prior to the replacement of the bridge in 1990.

Prepared by Lynne Emerson Monroe, Preservation Company, 5 Hobbs Road, Kensington, New Hampshire, for the New Hampshire Department of Transportation, Concord, New Hampshire.

1. Site Features and Historical Background

The Main Street Bridge is located in the town of Lancaster, Coos County, New Hampshire. Lancaster is advantageously situated on the southeast bank of the Connecticut River, but the village center developed 1.5 miles inland on Israels River. The Israels River is approximately 21 miles long and flows in a general northerly direction of the town of Lancaster, where, it turns to flow westerly to its confluence with the Connecticut River. While Lancaster itself is not mountainous, it is surrounded by the White Mountains, the Franconia Hills, and the Green Mountains of Vermont. The land terraces up gradually from the Connecticut Valley, with good farm land on the lower slopes and excellent woodland and lumber resources on the higher hills.

Coos County, or the Upper Cohos (Cohoss) territory, situated in the upper Connecticut River Valley, was explored by military parties as early as 1754. Word of the fertile and expansive lands known as Cohass Meadows soon became known among prospective settlers in lower New Hampshire and Massachusetts (A.N. Somers, History of Lancaster, New Hampshire, p. 17). At the close of the French and Indian War, with the elimination of the threat of incursions by the St. Francis Indians, New Hampshire's provincial governor, Benning Wentworth, granted (on July 5, 1763) a town charter for the "Upper Coos Meadows" and the water power privilege of the Israels River to David Page and 69 other incorporators of Petersham, Massachusetts (C.W. Closs, Determination of Eligibility, p. 11).

The center of Lancaster village, in its embryonic stage, was located at the north end of Main Street, near the dwelling (and later, tavern) of Col. Jonas Wilder. Wilder came to Lancaster in 1778 and purchased a square mile tract of land which extended south from his home along Main Street to the Israels River crossing (Historical Sites & Houses of Lancaster, New Hampshire, p. 21). A ford ("the fording place") was used to cross the river on Main Street until c. 1790, when Emmons Stockwell erected the first wooden bridge ("Stockwell's bridge") (Somers, pp. 62, 63).

The market prosperity of agriculture in the closing decade of the 18th century stimulated road building for improved trade and communication. The original roads laid out were the Dalton road and North and South Main Street (Closs, p.11).

Col. Jonas Wilder erected a gristmill and sawmill on Israels River in 1778. These mills operated into the 1840s. Emmons Stockwell leased, in 1792, the mill privilege on the site of the dam of the future Frank Smith & Co. mill, just east of the Main Street bridge. Stockwell released this site to Titus O. Brown, which entailed construction of a gristmill, sawmill, and fulling mill, all to be erected by the end of 1794 (Closs, p. 12). These mills, and their successors, together with

development of additional fulling and carding mills on the south bank of the river (Mill Street) after 1830, signaled the beginning of the growth of the town's industrial economy in the south portion of the village. (Somers, pp. 380-383.)

The first decade of the 19th century included significant events which stimulated the commercial development of Lancaster village. In 1805 "Stockwell's bridge" was replaced by an improved wooden span. With the establishment of Lancaster as the county seat in the same year, the mercantile trades were stimulated; lawyers, doctors, surveyors, and other professions were attracted to the town as Lancaster became a place of regional business (Closs, p. 12).

Lancaster's population grew to 717 by 1810; additional grist and fulling mills were being built. In 1820 there were four stores, two taverns, and four schoolhouses in the town, and three doctors, three lawyers, and one minister (Brackett, p. 12). An agricultural society was founded in 1821. Improvements in the principal roads down the Connecticut River and particularly through the White Mountain notch gave Lancaster an advantage; Portland, Maine, became the chief market and port with which the town and all of those north of it traded (Somers, p. 117).

Several events marked a turning point in the commerce and industry of Lancaster during the decade 1850 - 1860. The railroads (Atlantic & St. Lawrence Railroad - later the Grand Trunk) reached Northumberland, only 10 miles distant, by 1852; the Boston, Concord, and Montreal Railroad was constructed to Littleton the following year. The lumber trade, exploiting the vast, untapped spruce and hardwoods of the northern forest, suddenly became marketable with the advent of rail transportation and reduced freight rates (Somers, p. 171).

The Connecticut River was also used for log drives, taking the timber south. The prosperity of the town increased, and by 1850 the population was 1,559. The village center was well established and subdivision of the land grants and agricultural settlement continued. In 1848 a new latticed truss bridge was built at the Israels River crossing. (Closs, p.12) Once the town's natural beauty in the center of the White Mountains was made accessible by the railroad, Lancaster benefited from the resort industry which was developing in the region.

In 1862 the Main Street bridge was replaced with the first covered wooden span, which was to serve until its partial destruction by the spring floods of 1886 (Somers, p.64).

In 1866 the American Telegraph Company (Western Union) lines were extended to Lancaster from Littleton, providing for the first time instant communication with the larger urban center (Somers, p.150). The Boston, Concord and Montreal Railroad (Boston & Maine Railroad) was delayed in reaching Lancaster by the Civil War, but the first station was finally erected on the corner of Main and Railroad Streets in 1870;

this was followed by the Maine Central Railroad in 1890 (Two Hundred Years, p. 36; Somers, p. 277). The population of Lancaster village was 1100 in 1870, of a total number of 2248 in the town (Somers, p. 151).

After the Civil War, the state of New Hampshire began to dispose of its great tracts of lumber in the White Mountains, which spurred a lumber boom in the region. Additional incentive was that Maine's timber resources were suffering from reckless and heavy cutting, so loggers and speculators simply moved from Maine to New Hampshire. Lancaster became the regional center for the lumber industry, and many citizens were surveyors or investors in one of the numerous lumber companies. There were saw mills in several parts of town and a large paper mill (200 Years, p. 38).

Natural disasters, fire and floods, altered the character of the village. The flooding in 1870, 1886 and 1895 caused extensive damage to the Main Street bridge and mills east of the bridge. In 1886, the first iron bridge was erected by the Boston Bridge Company on the site of the 1862 wooden covered bridge, and a second structure had to be built after the floods in 1895 (Somers, p. 64, 65).

At the turn of the century, Lancaster was still experiencing prosperity as the focus of the region's activities. It was the center for railroads, telephone and power companies, and civic and economic activity. The transportation network was complete, giving the once remote town easy access to other settlements. Regional prosperity added to the town's particular prosperity and the town continued to grow, reaching a peak in 1890 with a population of 3,373 people. In 1903, a series of fires destroyed the remaining timber in the area, and after that the population began a gradual decline.

After the turn of the century, the decline of logging and the rise of popularity of the automobile affected the railroads and they began to close down operations. By 1929 both the Boston and Maine and Maine Central had moved out of town. Unfortunately, at the same time, the power companies, telephone, telegraph, gas company and electric, consolidated, and closed their Lancaster offices and left town, so during the middle of the 20th century the town experienced an economic decline.

In 1929 the Main Street iron bridge (1895) was replaced with the current, Luten-design, reinforced concrete structure, the eighth bridge to span the Israels River at this location (Closs, p. 14).

2. Bridge Description

The Main Street bridge is a double-span, reinforced concrete closed-spandrel arch highway bridge employing the Luten truss in four arch ribs bearing upon a pier and abutments of reinforced concrete. The two lane structure, aligned on a north-south access, is 106' in length

with a deck width, curb to curb, of 30' flanked by two 5' sidewalks. The overall width, cut to cut, is 40'.

The two 50' spans are symmetrical, but the elliptical arches are each asymmetrical. The overall feeling of the design is simple and light with clean lines. The center pier is a tapered wedge shape with the four arch ribs engaged in four sections each 5' x 8' square at the base tapering to approximately 5' square at the deck. The haunch of each arch rib is engaged in the pier rising only 7' 6¼" to the crown. The crown has only a 9" covering above the top, with 8" for the deck and 1" for the wearing surface. From the center the arches sweep to the abutments engaging them 4' lower than at the pier. The four arch ribs are identical, each 1' thick. The abutments are also of reinforced concrete combined with the old cut granite block abutments of the previous bridge and the granite retaining wall on the north bank of the river.

The interior truss system is composed of a series of 3/4" steel reinforcing rods arranged in the distinctive pattern known as the Luten truss. The steel rods are placed in a system of loops near the ends of the arch at the abutment and pier. Similar rods are laid near the inner surface of the crown of the arch. The system of connecting the rods to the pier involves bending and crossing the rods. Construction joints are placed at the pier and the haunch of each arch. ½" stirrups are utilized throughout the arch, the abutment and in tying the walkway to the deck (Appendix I).

The 5' concrete walkways are cantilevered from the east and west sides of the bridge. These are supported by a single reinforced concrete bracket which extends from the pier in the center. These walkways are edged by a 3' 8" high parapet wall. The parapet wall is solid, decorated on both sides by a system of long and short rectangles. These are beveled for accent and distinguished by a rough concrete finish, from the polished surface of the rest of the bridge. These panels range between square pedestals located at the center and north and south end of each arch. The south approach is distinguished by 6' wing-walls of reinforced concrete decorated similarly to the parapet. The wall on the east is flared slightly due to the position of the buildings. A wrought iron fence is attached to the west wall. This fence remains from the 1888 iron truss bridge (200 Years, p.22).

Four aluminum light standards surmount the pedestals on each corner of the bridge. The lights are supported by simple posts with the light standard capped by a saucer shaped aluminum shade. These lights were installed in 1963 (Donald Crane Letter, 1963) replacing the original concrete light standards which consisted of fluted columns capped by round globes.

Four bronze plaques are attached to the pedestals beneath the light standards. These plaques were moved from the previous bridge where they

were installed in 1921 (Coos County Democrat, April 13, 1921). The inscription on each is identical and reads:

> These standards are affectionately
> dedicated to the brave sons of
> Lancaster who sacrificed their
> all in the World War. 1917-1918.

A boxed conduit carrying the telephone and electric lines is attached to the bottom of the deck on the east side.

The bridge was damaged by an exceptional ice jam in the winter of 1968, and some consideration was given to replacing it. An ice-retention dam and reservoir was chosen as an alternate solution. Repairs to the bridge have included patching the concrete and resurfacing the wearing surface. (Bridge Maintainence Records).

The Federal Sufficiency Rating (FSR) of this bridge is 7.4 out of a possible 100. The bridge is considered structurally deficient due to the spalling and exposed reinforcing steel in the arch ribs as well as in the breastwall abutments. The concrete is salt laden causing accelerating deterioration of the superstructure. The deck shows fine cracks with both leaking and spalling visible. The bridge is in marginal condition for the current legal loads and is not considered adequate for "certified loads."

3. Construction

Records of the town of Lancaster indicate that Article 10 of the Town Warrant of 1929 asked what action the town would take in regard to reconstructing the Main Street bridge and raising money for same. The town appropriated $12,865.73 to match the funds allocated by the state under State Aid. The statement for the Trunk Line Bridge Account for the years 1929 and 1930 also shows this balance.

On March 20, 1929, the Coos County Democrat reported that the State had sent an engineer to Lancaster to take measurements preparatory to seeking bids. During March of 1929 the State of New Hampshire Highway Department designed a bridge for this site (Drawings on file NHDOT). It was described as the "Proposed Trunk Line Bridge, 1929, Town of Lancaster over Israel River on the Daniel Webster Highway in Village" (NHDOT). These plans were drawn, traced, checked and approved by April 4, 1929. They called for a single arch reinforced concrete bridge with a cantilevered walkway supported by a series of brackets and protected by a Beaux-Arts bottle balustrade

The project was opened for bidding on 4/11/29 and three bids were received. Bid A from the Robie Construction Company of Manchester, N.H. for $49,076.75; bid B from the H.J. Cyr and Company of Waterville, ME.

for $50,863.25; and bid C from the Luten Bridge Company, Inc. of York, PA for $47,480.25 (Records, NHDOT). A new set of plans dated April 16, 1929 was submitted by Daniel B. Luten, Designing Engineer, Indianapolis, IN. The new bridge designed by Luten was a double-span reinforced concrete bridge. The Luten Bridge Company was authorized by the NHDOT to build this bridge in a letter dated April 27, 1929. The guaranteed maximum total cost to the state and town amounted to $24,070.00. (Records, NHDOT).

The Coos County Democrat of May 29, 1929 reported that

> "construction work on the new bridge has been mostly destruction work during the past week and the bridge is practically demolished ready for the new structure to begin".

On June 19, 1929 the paper reported,

> "Bridge construction appears to be delayed by a smaller crew than appears necessary. It is the opinion of the laymen unskilled in bridge building that the work is of sufficient importance to the community to warrant a larger crew of men. The townspeople are not yet able to understand why construction work cannot go on at both ends of the bridge, since the earliest possible opening to traffic is desired."

The Wednesday, August 14, 1929 Democrat reported,

> "Cement Bridge Ready in Two Weeks. Work on the new bridge over Israels River is progressing very satisfactorily and is expected to have sidewalk on the east side ready for use by Saturday and the rest of the roadway poured by Tuesday. This latter will have to "set" sometime before traffic can pass over it, but in about two weeks forms should be down and the completed bridge in use. Cement pillars are being constructed for lights and will be very dignified and attractive when completed, much more so than the iron standards originally intended. The sidewalk from in front of Sullivan's Drug Store to Pelton's Grocery is being straightened and the street widened at this point which will be a big improvement. Completion of the bridge will be a great help to tourist travel and it is hoped that this

relief will improve business for September and October."

The August 21, 1929 paper reported,

> "The bridge is open. Another important construction job has been progressing rapidly and late Monday afternoon the first car passed over the new cement bridge. It is now open to the public although there is work yet to do. The public was restless at first when the work was dragging, but the money consideration did not permit bringing large machinery from Pennsylvania, and furthermore, the restricted area for working was an unsurmountable handicap. All in all there has been no needless delay and 88 days only were required for the $25,000 structure.
>
> The Luten Bridge Company of York, Pennsylvania and Concord, New Hampshire are the builders. The new bridge is 125 feet long and 40 feet wide and this includes a 5 foot walk for pedestrians on either side of the roadbed. The cement sidewalls have been paneled and roughed and the rest of the bridge work is being polished. There will be six lights of 200 watts each on the attractive light standards and these standards replaced the memorial standards of the old bridge. The bronze memorial tablets have been placed below the new standards. The new bridge has a center pier five feet below the river bed. The piers at each end are of about the same depth. The approach of the bridge from the north will be another improvement when completed as this congested section will be widened four feet."

The designer and contractor for the Main Street bridge was Daniel Benjamin Luten. Luten was a nationally known designer, nearly solely responsible for the explosion of concrete bridge construction during the first quarter of the 20th century (Colorado Bridge Survey, 1986, p. 10).

Luten was born in Grand Rapids, Michigan, December 26, 1869, and died in Indianapolis, Indiana July 3, 1946. He was an instructor in civil engineering at the University of Michigan, 1894 to 1895, and Purdue University in Indiana, 1895 to 1900. He married Edith Heath Hoe, a wealthy society woman from Indianapolis June 20, 1900 and opened a consulting firm designing concrete bridges in Indianapolis in 1900

(Indianapolis Star, 1946, p. 14 and Who Was Who in America, 1950). He created several regionally based companies for various aspects of the business (D.C. Jackson, Great American Bridges and Dams, 1985, p. 36), known variously as the National Bridge Company, which was the designing engineering firm, and the National Concrete Company which was a construction firm. He also ran his business under the name of Luten Engineering Company. He is known to have had offices in York, Pennsylvania.

Luten was an unusually successful entrepreneur. He designed simple, light bridge designs intended to work and perform well. They were cheaper to build. The clever designs combined with a hold on patents and efficient production methods made him a force to contend with. He built thousands of bridges in North America in areas as diverse as Florida, Colorado, and Mexico.

Within the state of New Hampshire Luten is known to have built at least fifteen bridges. Although the correspondence is addressed to Daniel Luten, Concord, New Hampshire, city directories show no record of either a residence or office listing during this period.

Luten's bridge business failed during the Depression and he started a broom factory (Personal Communication, Cooper 1989).

4. Design and Technology

In the late 19th century bridge engineers began to develop designs using reinforced concrete. Initially, these designs followed the traditions of masonry building closely with little innovation. They were massive, full centered vaults with solid spandrels. Gradually engineers began to develop more daring designs that differed in size, scale and form masonry. Two major systems of reinforcing were the Melan system of arches with iron truss reinforcing and the Ransome method which was slightly more scientific utilizing bar reinforcing. The most significant innovation in reinforcing was introduced around 1900 by Daniel Benjamin Luten. Luten system of reinforcing involves several bars forming a complete loop laid transversely through the vault and bed and a series of loops laid at regular intervals throughout the length of the structure. The bars are bent to conform to the semi-circular or elliptical section of the vault and the shallow curve of the trough-like invert. They lie near the surfaces of maximum tension under the live load. They were particularly popular for highway bridges a because of the problem of absorbing high impact loads. Concrete bridges were considered more visually attractive than steel truss bridges. They were therefore selected for sites in picturesque locations or fashionable urban areas. (Condit, 20th Century, p. 197).

Luten was a skilled engineer and successful entrepreneur. He designed an innovative system of reinforcing concrete featuring arches with highly

elliptical profiles. They were sophisticated in their dependence on steel reinforcing and allowed relatively thin concrete sections at mid-span. These became known as Luten Arches. Luten took out a series of wide ranging patents between 1900 and 1906 for reinforced concrete arches. This gave him control of the concrete bridge industry in America. The lawsuits held up in court forcing virtually all arch builders to pay patent royalties to Luten. His strangle hold on the industry was finally broken in January 1918 when a Des Moines, Iowa judge ruled the patents invalid (Colorado Bridge Survey, 1986, p.10).

Luten's lightweight, sleek designs became particularly popular in picturesque areas. He touted his semi-elliptical arch as "the flattest arch in the world" (Engineering News, Nov. 13, 1902). Bridges built utilizing this arch are simple and graceful. Usually they are single or multiple spans featuring a closed-spandrel barrel vault with a through-deck decorated with a variety of balustrades.

The Main Street Bridge represents a deviation from the known designs by Luten. It is clear that his need was to design and build the most economical bridge for the site. Luten first underbid his competitors on the original design proposed by the New Hampshire Highway Department and then immediately submitted his own innovative design, offering to build this different structure for half the price. He was able to achieve this astounding difference by employing a design directed to saving materials.

Saving materials was critical since Lancaster is situated in a remote region of the state. Transportation and material costs would have been high. By utilizing a double arch rather than single arch and series of four parallel ribs rather than the solid barrel vault, Luten was able to save a substantial amount of concrete. The difference in cost of reinforcing was also notable. Although the cost of forming would have been higher for the rib design, wooden materials and carpenters were readily available in a lumbering region. Even though building a heavy pier system was expensive, the trade-off was that it was still cheaper to build two lighter arches rather than one, heavily reinforced arch span, because of the saving on steel and concrete. This is the only known two span use of arch ribs, in the state and considered unusual in the body of Luten's work (Personal Communication, Cooper 1989).

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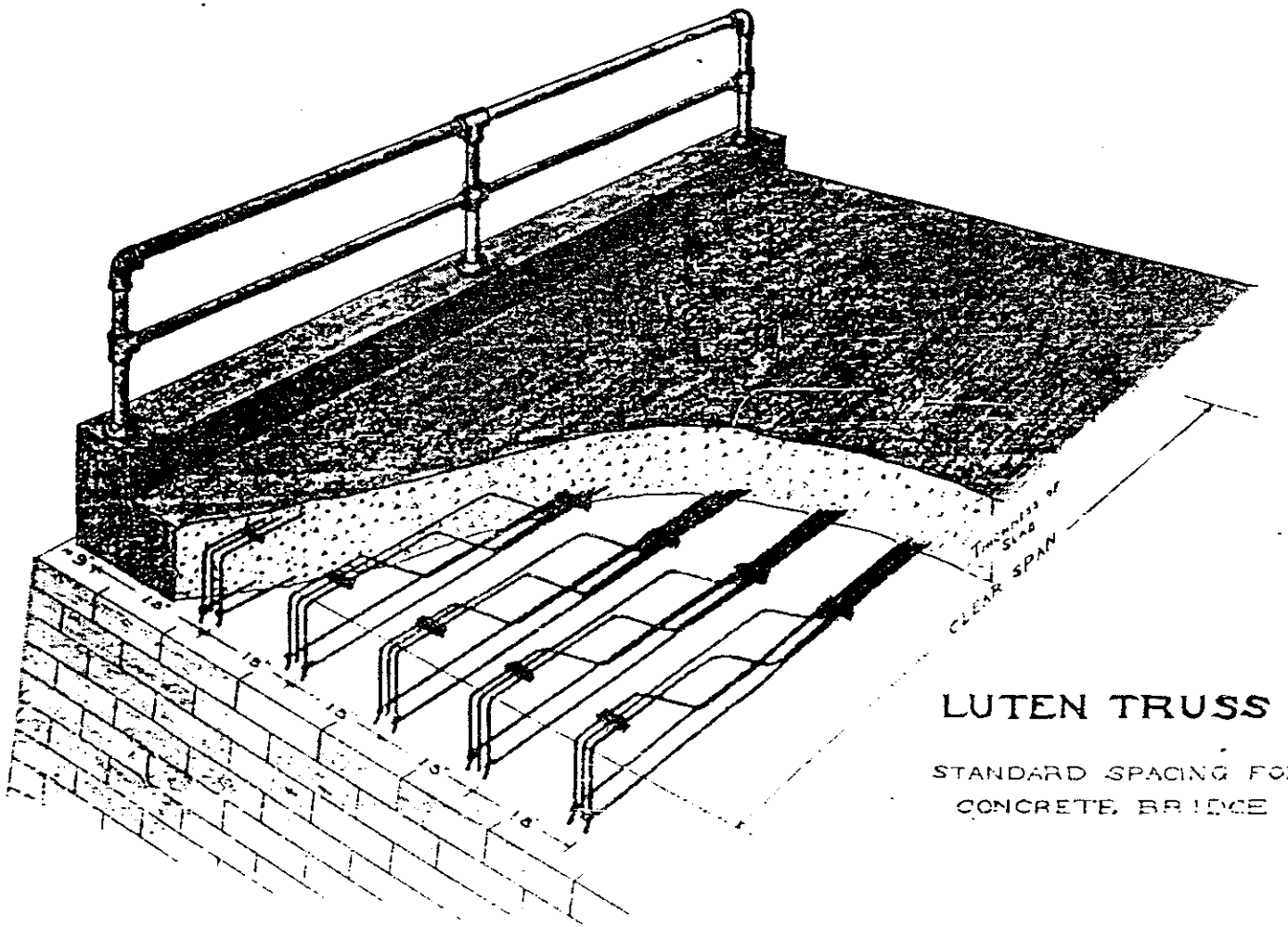
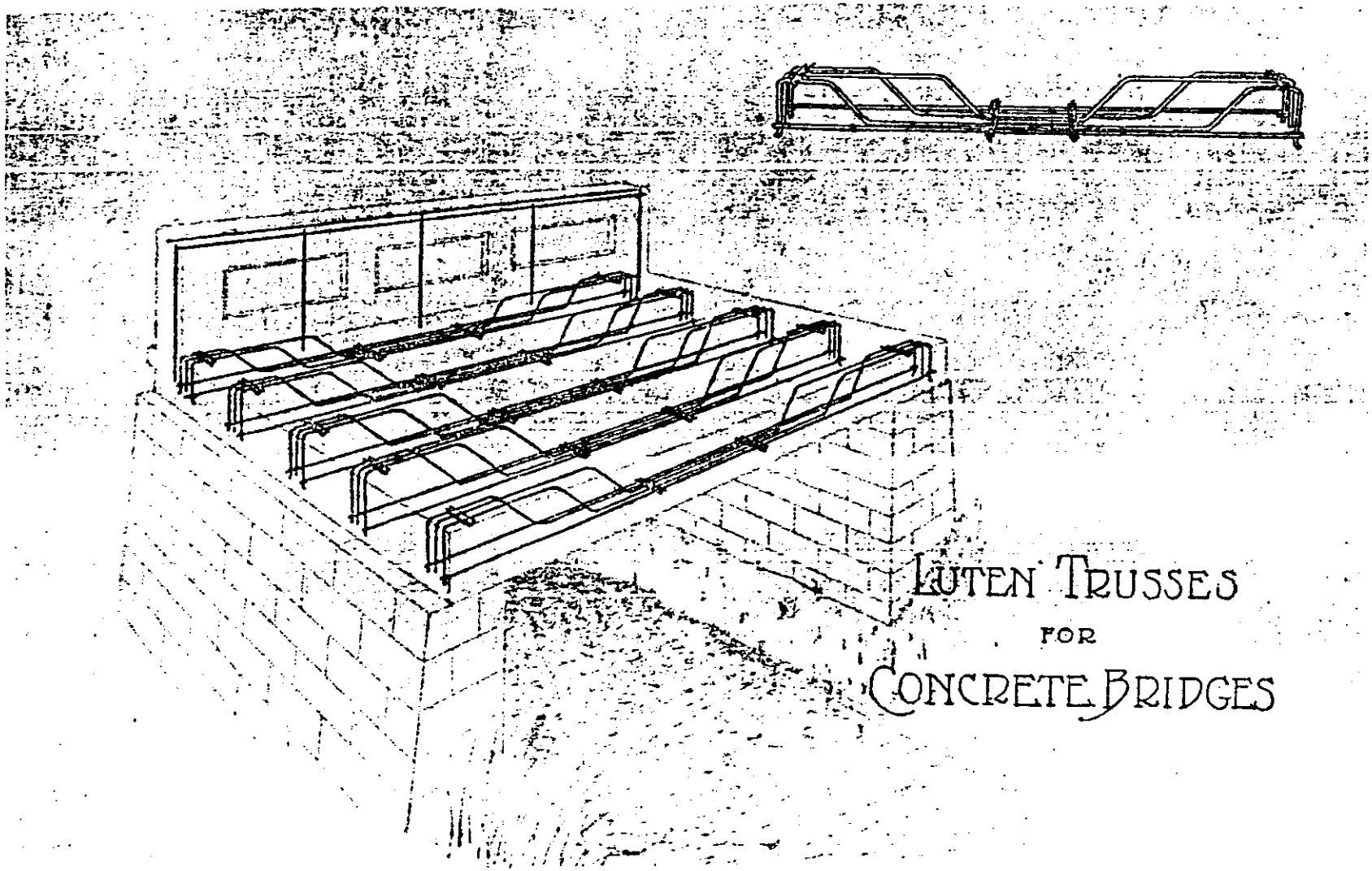
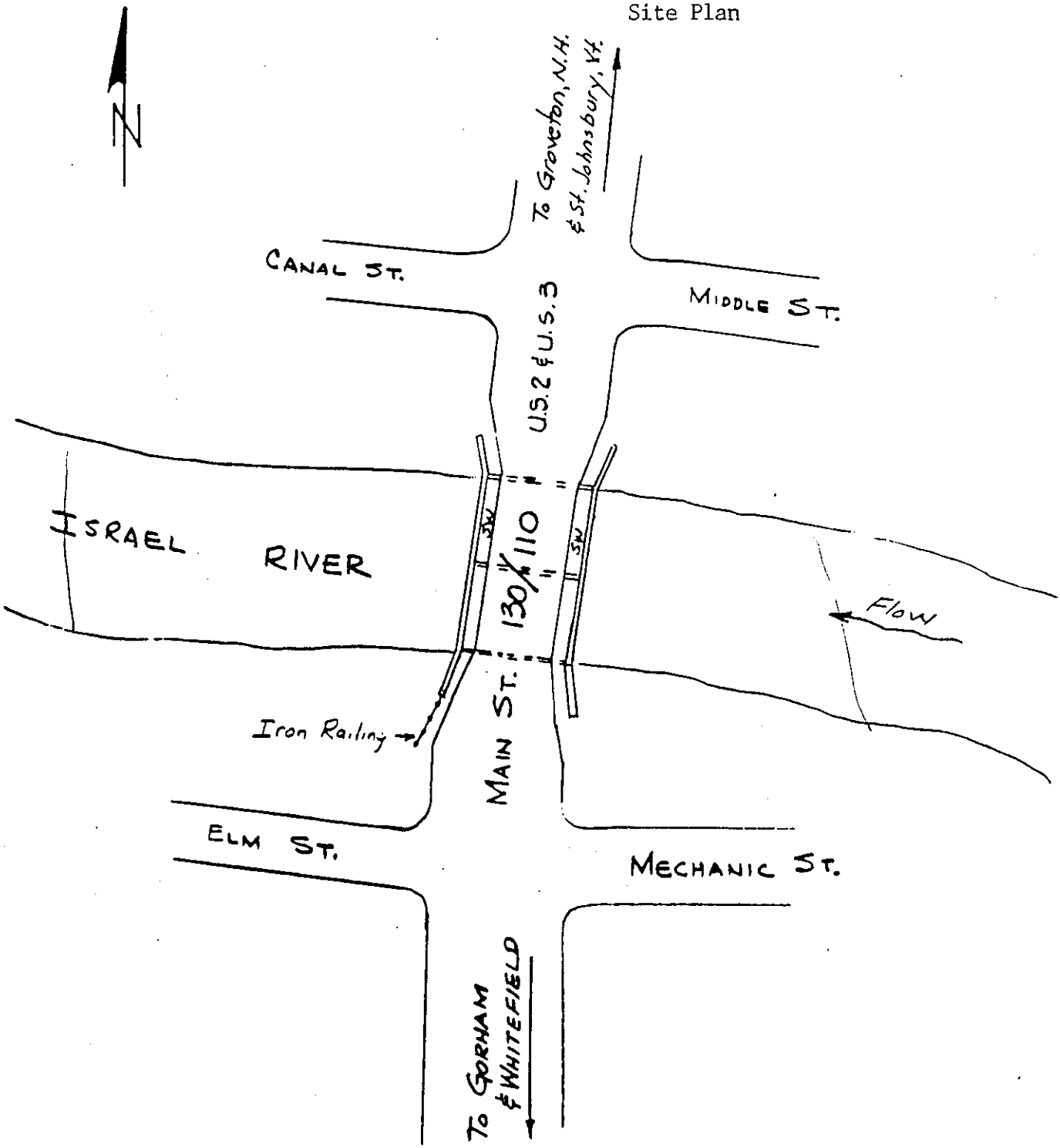


Source: The Luten Truss, a brochure by the National Concrete Company, Indianapolis.



Site Plan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MECHANIC ST.
To GORHAM
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